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Meningomyelocele defect repair: surgical technique selection

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ABSTRACT

Aims: Surgical repair of meningomyelocele is important in terms of infection, cerebrospinal fluid (CSF) leakage, and preservation of neural structures. While there are numerous techniques available for repair, there are few guidelines on when flap repair should be performed. In this study, we employed a method to select the surgical technique.

Methods: Thirty-two patients with meningomyelocele who underwent surgery were included in the study. The decision to use or not to use a flap was based on the ratio of defect height to width and the ratio of the axillary line to defect width.

Results: Fasciocutaneous transposition flap (FTF) repair was performed in 17 patients, whereas primary repair was performed in 15 patients. There was no statistically significant difference between the groups in terms of preoperative characteristics of the patients. In the FTF group, one patient experienced necrosis at the wound site, and one patient developed a cerebrospinal fluid fistula. In the primary repair group, necrosis was observed in one patient, CSF fistula developed in two patients, and central nervous system infection developed in one patient. No statistically significant difference was found between the groups in terms of complications.

Conclusion: The results obtained in the present study suggest that the shape of the defect and the ratio of intact tissue to defect size are more important than the size of the defect itself in achieving appropriate tension during repair. By employing the patient selection guidelines we achieved successful outcomes using a different flap technique.

Keywords: Meningomyelocele, spinal dysraphism, postoperative complications

INTRODUCTION

Meningomyelocele is the most common congenital anomaly of the central nervous system (CNS) compatible with life. During embryonic development, it presents as a defect in the closure of the neural tube. Genetic, nutritional, and ethnic factors play a role in its manifestation. The incidence varies between 0.17 and 6.39 per 1000 births.[1] In patients with meningomyelocele, neural tissues, along with meningeal structures, externally herniate to varying degrees. The repair of this defect is important for preserving neural tissues, avoiding CSF leakage, and preventing infections.[2]

Various techniques for defect repair have been described in the literature. There are techniques applied in musculocutaneous and cutaneous styles, as well as rotational, transpositional, single-pedicle, and multi-pedicle techniques. The aim of all techniques is to close the defect as early as possible and with the lowest rate of complications. Different approaches have been followed in determining when flap repair should be performed in patients; however, there are few guiding studies on this.[3-6]

The aim of the present study was to present the approach used in selecting the surgical technique and compare surgical results and early postoperative outcomes in patients with meningomyelocele operated on by a single surgeon.

METHODS

The entire study was conducted in accordance with the Helsinki Declaration of 1975 (as revised in 2004 and 2008) This retrospective cohort study was approved by the Ethics Committee of Harran University (HRU/23.24.03). Since this was a retrospective study, consent was not obtained from the patients or their relatives.

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The study included 32 patients with meningomyelocele operated on by a single surgeon at our Hospital between March and September 2023. Data on the preoperative and postoperative conditions of meningomyelocele patients were accessed through the hospital information management system. Preoperative, intraoperative, and postoperative characteristics were examined, and patients for whom sufficient data regarding these characteristics could not be obtained were not included in the study. The patients were followed up in the neonatal intensive care units, and follow-up notes were recorded daily in the system.

The surgical procedure was performed in the same way in all patients until skin closure. All patients were operated under general anesthesia in the prone position. In all patients, the neural placode was identified under neuromonitoring, and it was sutured with 4-0 vicryl suture. The dura was then freed from the surrounding tissue and closed watertight with a 4-0 silk suture. No artificial dura was used in the patients. If necessary, duraplasty with fascia was performed, and all patients underwent watertight primary suturing to repair dural defects. After closing the dura in all possible cases, the skin defect was closed with primary suturing using 2-0 prolene suture (Figure 1). In patients in whom primary suturing was not possible, the skin defect was closed using a unilateral FTF, and the defect was sutured with 2-0 prolene suture (Figures 2, 3). Patient selection was made according to the guidelines reported by Kemaloğlu et al.[7] when deciding on the repair technique. Kemaloğlu et al. stated in their guidelines that; if the defect height/width ratio was ≥1.5, two parameters were evaluated: if the ratio of the length between the posterior axillary lines to the defect width was ≥3, primary repair was performed; if the ratio was <3, FTF repair was performed. If the defect height/width ratio was <1.5, FTF repair was performed. The longest diameter of the defect was considered when calculating the flap size during repair. A fasciocutaneous flap of appropriate size, 1 or 1.5 times the length of the defect diameter, was used to repair the defective area from a region parallel to the defect. No drain was placed under the skin or tissue adhesive was applied.

Figure 1. Patient with cerebrospinal fluid (CSF) fistula after primary repai

Figure 2. Images showing the fasciocutaneous transposition flap before suturig

Figure 3. Images showing the fasciocutaneous transposition flap after suturing

The preoperative characteristics of patients were compared based on the surgical technique applied, and statistically significant differences were evaluated. Birth week, maternal age, birth weight, Apgar scores, additional anomalies (such as ventricular septal defect, atrial septal defect, patent ductus arteriosus, necrotizing enterocolitis, herniation), presence of motor deficit, surgical intervention time interval, defect localization (classified as cervical-thoracolumbar), and defect size (classified as <5 cm, 5–8 cm, and >8 cm) were reported for all patients, and statistical differences among the patients based on the type of surgery were assessed. All motor deficits observed below the level of the lesion in patients were grouped together under a single category without distinction.

The examination of postoperative characteristics included analyzing patients for wound necrosis, CSF fistula, ventriculoperitoneal (VP) shunt requirement, CNS infection, length of hospital stay, and mortality. Postoperative head circumference was monitored daily. In patients with symptomatic hydrocephalus diagnosed by Transfontanellar Ultrasonography (TFUS) or other cranial imaging methods showing a significant increase in head circumference, a VP shunt was placed. The diagnosis of CNS infection was based on the CSF culture results.

Statistical Analysis

Statistical analysis were conducted using SPSS 29.0 software package. A p value of <0.05 was considered statistically significant in all analyses. Chi-square and Fisher's exact tests were used to compare independent categorical variables, and variables are presented as numbers and percentages. The conformity of independent continuous variables to normal distribution was evaluated using Shapiro–Wilk test. Since none of the variables followed a normal distribution, the Mann–Whitney U test was used to compare continuous

Table 1. Relationship between surgical technique and the preoperative characteristics of the patients included in the study

Preoperative characteristics	Total	Surgical Technique		p	OR (95% GA)
		1(FTF) n (%)	2(Primary) n (%)		
Gender					
Female*	26 (81.2)	16 (94.1)	10 (66.7)	0.076[1]	0.125 (0.013-1.232)
Male	6 (18.8)	1 (5.9)	5 (33.3)		
Age of mother				0.766[2]	1.009 (0.909-1.120)
Median (25p-75p)	24.5 (21.0–29.7)	24.0 (21.0–30.0)	25.0 (21.0–29.0)		
Birth weight				0.682[2]	1.000 (0.998-1.002)
Median (25p-75p)	3100 (2900–3300)	3000 (2930–3225)	3100 (2700–3400)		
Birth week					
<37 weeks*	6 (18.8)	4 (23.5)	2 (13.3)	0.659[1]	0.500 (0.078-3.223)
37–42 weeks	26 (81.3)	13 (76.5)	13 (86.7)		
APGAR (minute 1)				0.502[2]	0.912 (0.585-1.421)
Median (25p-75p)	8.0 (7.0–8.0)	8.0 (7.0-8.0)	8.0 (7.0–8.0)		
APGAR (minute 5)				0.941[2]	0.968 (0.567-1.652)
Median (25p-75p)	9.0 (8.0–9.0)	9.0 (8.0–9.0)	9.0 (8.0–9.0)		
Additional anomaly					
No*	27 (87.1)	15 (88.2)	12 (85.7)	1.000[1]	0.198 (0.044-0.904)
Yes	4 (12.9)	2 (11.8)	2 (14.3)		
Motor deficit					
No*	14 (43.8)	8 (47.1)	6 (40.0)	0.688[3]	0.750 (0.184-3.057)
Yes	18 (56.3)	9 (52.9)	9 (60.0)		
Defect localization					
Cervical*	1 (3.1)	0 (0.0)	1 (6.7)	0.469[1]	-
Thoracolumbar	31 (96.9)	17 (100.0)	14 (93.3)		
Defect size					
<5cm	3 (9.4)	3 (17.6)	0 (0.0)	-	-
5-8cm	27 (84.4)	13 (76.5)	14 (93.3)		
>8cm	2 (6.3)	1 (5.9)	1 (6.7)		
Surgery time				0.313[2]	1.000 (0.979-1.022)
Median (25p-75p)	24.0 (24.0–48.0)	24.0 (24.0–36.0)	24.0 (24.0–48.0)		

[1] Fisher's exact test was used, [2] Mann–Whitney U test was used, [3] Chi-square test was used, * reference group for odds ratio

variables, and the findings were presented as median and 25th-75th percentile values.

RESULTS

The study included 32 patients, which included 81.2% (n = 26) women and 18.8% (n = 6) men. No significant difference was found in the preoperative characteristics of the patients with respect to the surgical technique. FTF repair was performed in 17 patients, whereas 15 patients underwent primary repair. All patients in the FTF repair group had defects in the thoracolumbar region, whereas one patient in the primary repair group had a defect in the cervical region. In the FTF group, the defect diameter was <5 cm in 3 patients, 5–8 cm in 13 patients, and >8 cm in 1 patient. In the primary repair group, the defect diameter was 5–8 cm in 13 patients and >8 cm in 1 patient (Table 1).

When postoperative characteristics were compared with respect to the surgical technique, necrosis at the wound site was observed in 1 patient in each group (p=1.000). CSF fistula was observed in 1 patient in the FTF group and in 2 patients in the primary repair group (p=0.589). There was no significant difference between the surgical techniques in terms of hospital stay, postoperative VP shunt placement, and CNS infection. One patient who developed a central nervous system infection was operated on the 72nd hour and presented with CSF leakage. Mortality occurred in four patients, two patients in the FTF group and two patients in the primary repair group (Table 2). Patients who developed necrosis at the wound site were followed up for wound care and monitored. Of the 3 patients who developed CSF fistula, wound revision was performed in 1 patient who underwent primary repair.

DISCUSSION

This study was conducted in Şanlıurfa province, which has the highest birth rate and consanguineous marriage rate in Turkiye (TurkStat data). Therefore, it is reasonable that 32 patients were operated in a short time compared to other studies in the literature. In patients with meningomyelocele, the goal of surgical repair can be summarized as closure of the neural placode, prevention of CSF leakage, prevention of systemic and CNS infections, and preservation of neural function.

In the literature, it has been reported that primary repair is possible in 75% of patients, whereas various procedures are used to close the skin defect in 25% of patients.[3,4] Studies have been conducted on various repair methods including primary repair, skin grafts, muscle flaps, and fasciocutaneous

Table 2. Relationship between surgical technique and postoperative characteristics of patients included in the study

Postoperative characteristics	Total	Surgical Technique		p	OR (95% GA)
		1 n (%)	2 n (%)		
Necrosis at the wound site					
No*	30 (93.8)	16 (94.1)	14 (93.8)	1.000[1]	0.875 (0.050-15.326)
Yes	2 (6.3)	1 (5.9)	1 (6.7)		
CSF fistula					
No*	29 (90.6)	16 (94.1)	13 (90.6)	0.589[1]	0.406 (0.033-4.997)
Yes	3 (9.4)	1 (5.9)	2 (13.3)		
Postoperative hydrocephalus VP shunt					
No*	21 (65.6)	9 (52.9)	12 (80.0)	0.108[2]	3.556 (0.730-17.323)
Yes	11 (34.4)	8 (47.1)	3 (20.0)		
Length of hospitalization					
Median (25p-75p)	18.0 (10.0–38.0)	18.0 (10.0–38.3)	18.0 (7.0–31.0)	0.395[3]	1.018 (0.949-1.092)
CNS infection					
No*	31 (96.9)	17 (100.0)	14 (93.3)	0.469[1]	-
Yes	1 (3.1)	0 (0.0)	1 (6.7)		
Mortality					
Alive	28 (87.5)	15 (88.2)	13 (86.7)	1.000[1]	1.154 (0.142-9.385)
Dead	4 (12.5)	2 (11.8)	2 (13.3)		

[1] Fisher's exact test was used, [2] Chi-square test was used, [3] Mann-Whitney U test was used

flaps.[3,5] Regardless of the method used, tension should be minimized, CSF fistula should be prevented, and a soft support for the neural tube should be established. In their study, Haktanir et al.[5] used bilateral fasciocutaneous flaps for defect repair in patients with meningomyelocele and did not encounter any complications such as necrosis, wound dehiscence, or CSF fistula. Atik et al.[6] performed repair with a bilobulated fasciocutaneous flap in 20 patients and encountered a CSF fistula in 2 patients and flap failure in 1 patient.In their study, Mutaf et al.[8] developed a new technique called the triangle repair technique and encountered only minimal hematoma complications in one out of five patients. Kankaya et al. used a V-Y rotation flap in 17 patients and compared the dorsal skin and defect areas of the patients. They selected the flap technique for repair according to this ratio and applied bilateral flaps in 6 patients and quadrilateral flaps in 11 patients. Among the patients who underwent quadrilateral flap application, wound dehiscence occurred in one patient, whereas necrosis developed in another. No complications were observed in the other patients.[9] In a study conducted by Jabaiti et al.[10] complications developed in 7 of 48 patients. They reported necrosis in 3 patients, seroma in 2 patients, meningitis in 2 patients, and CSF fistula in 1 patient. High complication rates were reported in repairs made with large musculocutaneous flaps.[11] Anitha et al.[12] reported a total complication rate of 24% in their study involving 27 patients who underwent various surgical procedures using different techniques. They noted that the incidence of wound dehiscence was higher in patients who underwent primary closure.Sharma et al.[13] applied various techniques to achieve tension-free closure in 22 patients with meningomyelocele, reporting complications in three patients. In one patient who underwent a triple rotational flap procedure, necrosis at the wound site was observed, while in two patients who underwent Limberg flap and local transposition flap procedures, wound dehiscence was reported. Shim et al.[14] conducted a study involving 14 patients with meningomyelocele. Primary repair was performed in 12 patients, while repair using the Limberg flap technique was carried out in 2 patients, 2 patients experienced complications. When compared with musculocutaneous flaps, local cutaneous flaps are easier to apply because of reasons such as shorter dissection time and less bleeding. Therefore, many surgeons use cutaneous flaps in different techniques such as advancement flaps, transposition flaps, bilobed flaps, V-Z plasty, and Limberg flap. Limberg flap is a frequently used method where the flap is lifted from the defect periphery and does not cause damage in muscles. The fundamental element in reducing wound complications is tension-free closure. To achieve this, an understanding of flap principles is essential. Relying on a single defect width value is insufficient to determine the appropriate reconstruction method. If such an approach is employed, complication rates are likely to be higher, similar to those reported in the literature. Patients present with tissues of varying quality and availability. We believe that surgical planning is significantly more related to the success of a reconstruction. In the present study, we performed repair using fasciocutaneous transposition flaps in 17 out of 32 patients, where the flap was raised from the defect periphery similar to the Limberg flap and V-plasty. Primary repair was performed in 15 patients. The guidelines reported by Kemaloğlu et al.[7] were used to decide on the repair method for the patients.The ratio of the defect area to the dorsal skin area is more important than the defect area in flap usage. Therefore, repair with a fasciocutaneous flap in all patients where we anticipated high tension during repair, even if the defect diameter was <5 cm was preferred. In addition, if we anticipated that a tension-free closure could be achieved, we preferred primary repair even if the defect diameter was larger than 5 cm. Among the 17 patients who underwent flap repair, one patient necrosis at the wound site and one developed CSF fistula. In the primary repair group, necrosis developed in one patient and CSF fistula developed in two patients. One patient with CSF fistula was re-operated. Other

patients recovered following wound care and monitoring. In a study investigating postoperative infections in patients with myelomeningocele, the infection incidence was found to be 30%.[1] In another study, the rates of CNS infections were reported as 16%, and the rate of sepsis was 29%. The incidence of CNS infections was found to be higher in patients with larger defects and those whose surgeries were delayed.[15] It is hypothesized that delays in the surgical repair of myelomeningocele are associated with an increased rate of infections due to bacterial colonization, which may lead to wound infections or meningitis/ventriculitis post-repair.[16] In our study, a CNS infection was observed in a patient who underwent primary repair. This patient was operated on the 72nd hour post-delivery and presented with postoperative CSF leakage. Our overall rate of CNS infections is lower compared to the literature. When comparing surgical techniques regarding CNS infection rates, we did not find any significant differences. In the literature, complication rates vary between 7% and 33%.[17-19] In this study, the complication rate was 11% in the FTF group and 26% in the primary repair group. When we examined the defect diameter of patients who developed complications after primary repair, we observed that all patients had a defect diameter of >8cm and underwent VP shunt placement. This finding is consistent with the literature; the relatively high complication rate compared to flap repair may be related to these factors. Compared to the literature, the complication rates in the FTF group were considerably lower. When compared in terms of necrosis at the wound site, CSF fistula, CNS infection, mortality, and length of hospitalization, no statistically significant difference was found between the two surgical techniques. Upon examination of the preoperative characteristics of patients subjected to different surgical techniques, we discerned no statistically significant differences, thereby indicating the absence of any confounding factor impeding the comparison of surgical outcomes.

Limitations

The retrospective design was a limitation of this study. However, considering that the preoperative characteristics were examined in detail and no statistically significant preoperative differences that could influence the postoperative outcomes of surgical techniques were identified, our results seem to be consistent. Furthermore, the fact that all surgeries were performed by a single surgeon minimizes variations in surgical procedures.

CONCLUSION

Meningomyelocele is an important condition that requires close monitoring and early intervention from birth because it can lead to various complications if not promptly addressed. Implementing timely and appropriate surgical procedures after birth helps prevent potential complications that may arise later. Although various repair techniques have been described, we emphasized that proper patient selection is more crucial for the choice of repair technique. By utilizing the intact tissue-defect ratio, we found that the postoperative complication rates of the surgical techniques we applied were lower compared to the literature. The method of selecting surgical techniques in our study indicates that the ratio of the defect to healthy tissue is more important for repair under appropriate tension than the size of the defect itself.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of Ethics Committee of Faculty of Harran University (Date: 25.12.2023, Decision No: HRÜ/23-24-03).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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